

COMMUNITY
COORDINATED
MODELING
CENTER

Community Coordinated Modeling Center: Pioneering the Path from Research to Operations.

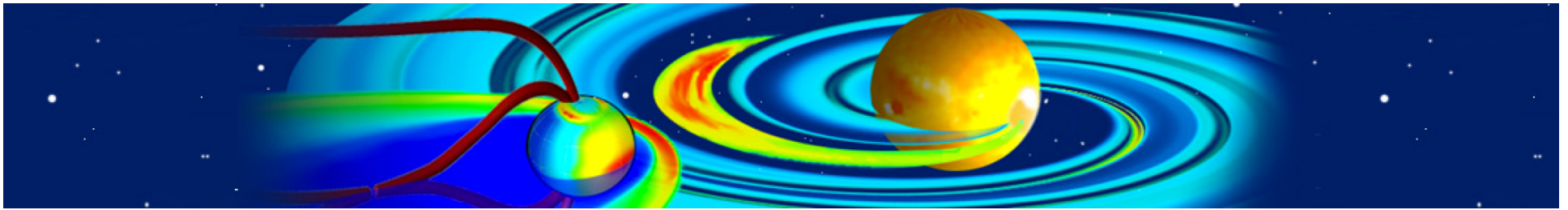


Space
Weather
Research
Center

*Masha Kuznetsova
& CCMC team*

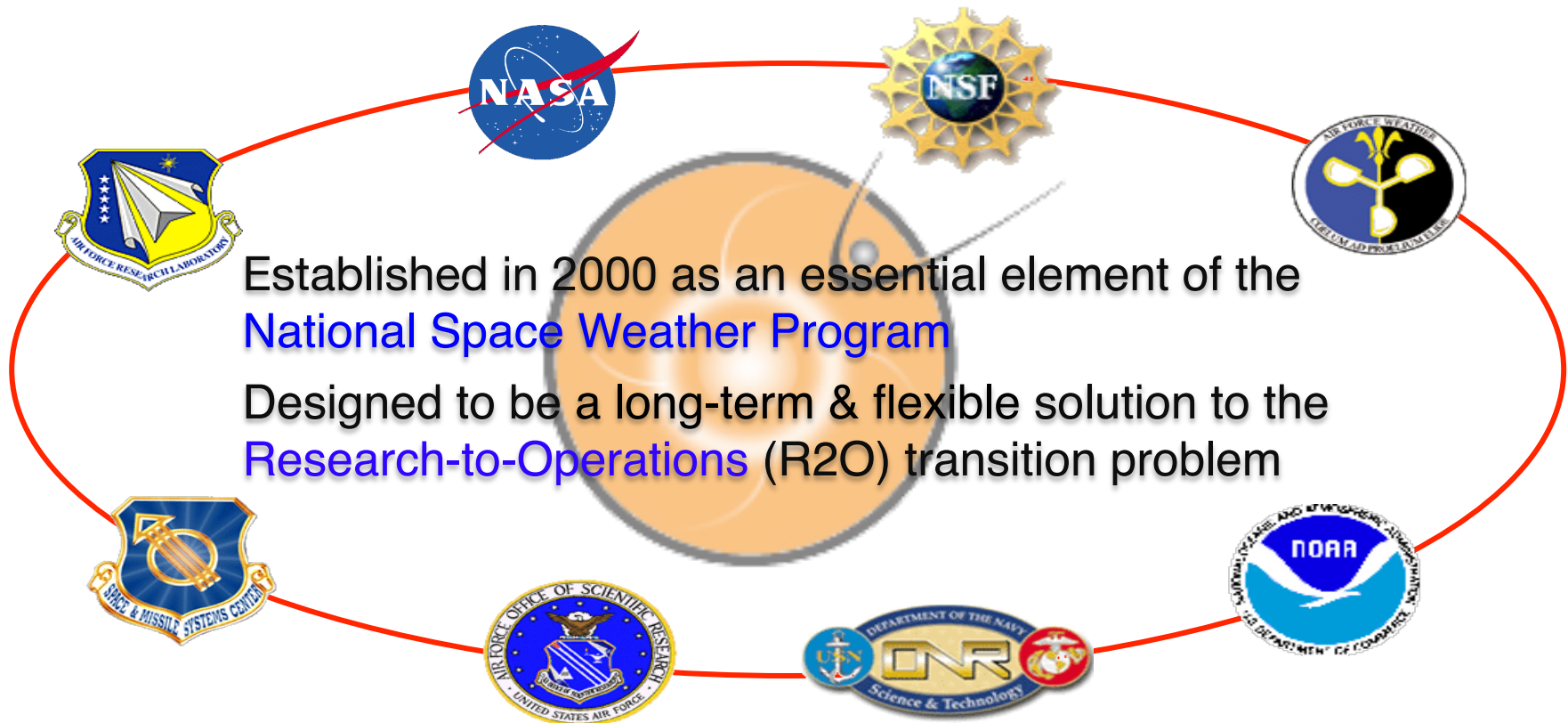
Space Weather Workshop
April 14 – 17 , 2015

MODELS • DATA • TOOLS • SYSTEMS • SERVICES • DATABASES

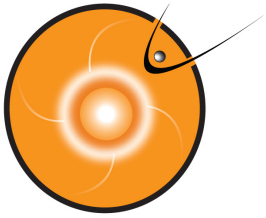


Community Coordinated Modeling Center

<http://ccmc.gsfc.nasa.gov>



*Prior to CCMC (past millennium): R2O “Valley of death”
Models accessed and used by developers only.*



Paving the Way From Research to Operations



Paved highway



Narrow bridge over
“Valley of Death”

VS.



R2O Transition Challenge 2015

Key Elements of R2O Transition (lessons learned)

Linking space environment with impacts

Actionable products

Communication, Coordination, Collaboration

Database of impacts

Guidelines on best practices, standards, naming conventions, etc

Flexible dissemination

Facility for rapid implementation.
Demonstrate operational potential.

Facilitate Research & Development

Data & model output accessibility

Robust (ops-ready) models

Validation & Assessment

Real-Time modular & flexible infrastructure

Addressing Needs of Users of Space Weather Services

Users

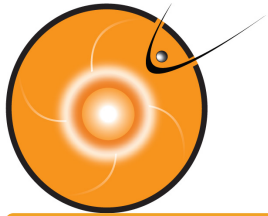
**Operational
Agencies**



Clearing House
*Rapid Implementation &
Unbiased Assessment*
Proximity to Models & Expertise
Coordinated by Community



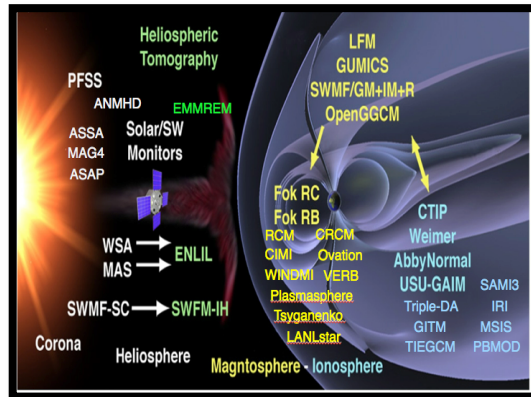
Research & Development



CCMC Assets & Services (elements of R2O transition)

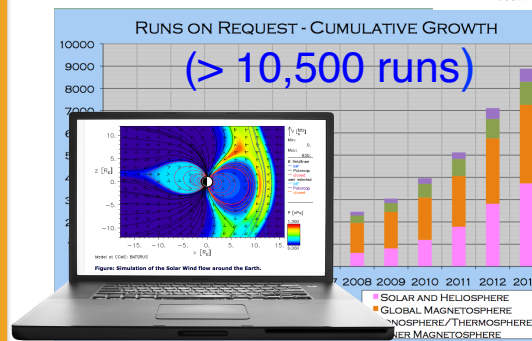


Models

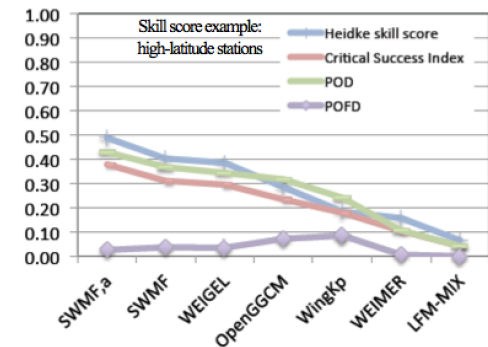


(expanding collection: > 60)

Simulation Services

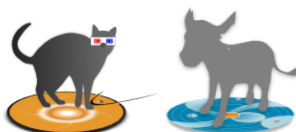


Assessment, Metrics & Validation



Tools, Systems, Databases

for dissemination, analysis, forecasting, validation



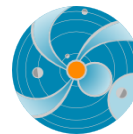
StereoCAT DONKI

FastTrack

ScoreBoard

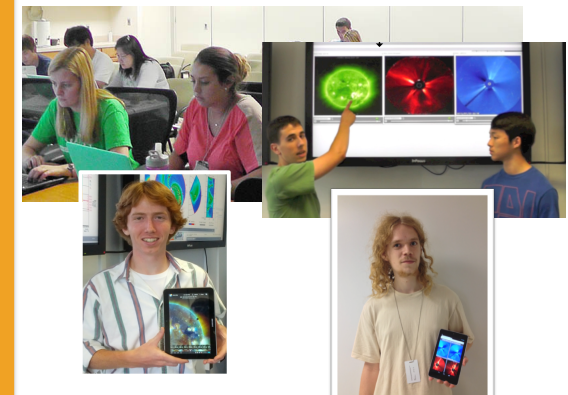
Space Weather Services

for NASA's missions

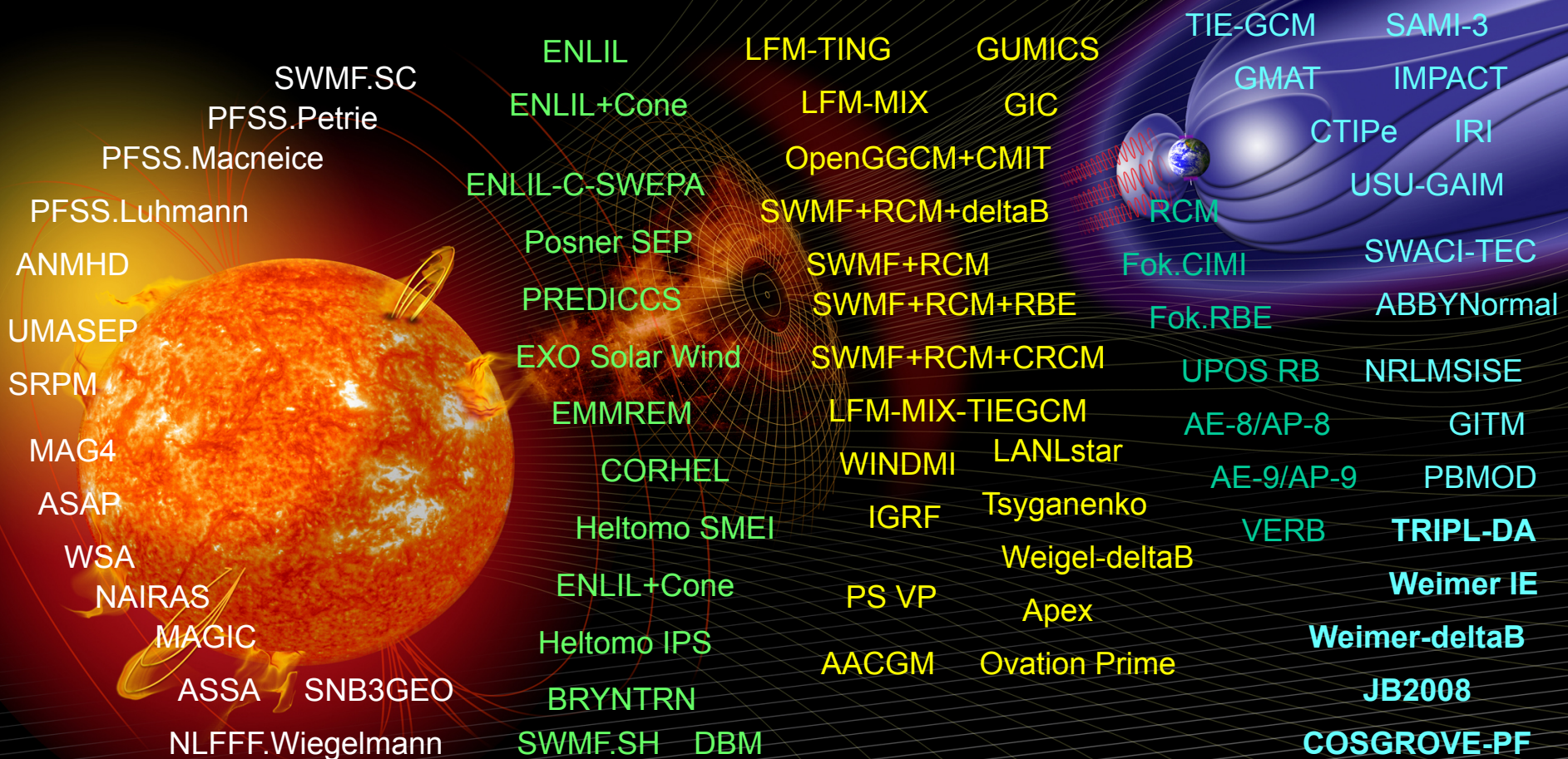


Space Weather Research Center

Hands-on Education



CCMC Assets & Services: Comprehensive Collection Of Space Weather Models



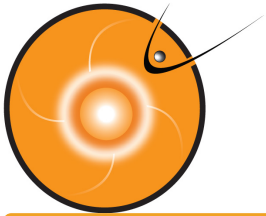
Corona

Heliosphere

Magnetosphere

Inner
Magnetosphere

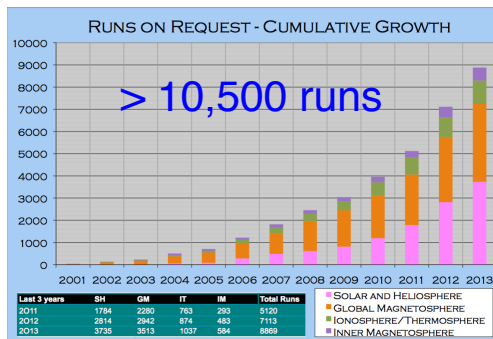
Ionosphere/
Thermosphere



Simulation Services



Runs-on-Request



Event-Triggered Real-time Simulations



FastTrack WSA-Enlil-Cone

Input Parameters Generation Tool



StereoCAT - CME Analysis Tool

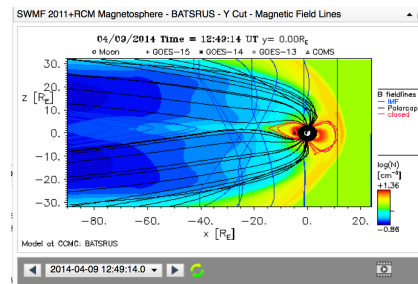
EEGGL – Eruptive Event Generator by Gibson-Low

Model Output Standards, Conversion, Access, Interpolation Libraries

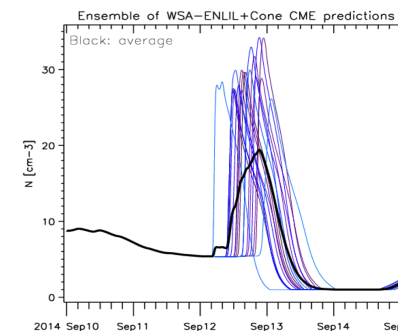


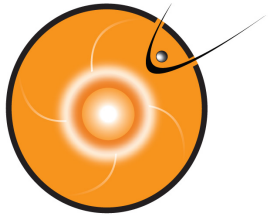
KAMELEON

Continuous Real-time Simulations



Ensemble Simulations





Multi-Purpose Tools, Systems, Databases & Actionable Apps



Data Management, Metadata, Standardization, Access



- Science Data Formats, Metadata
- Data Conversion
- Access & Interpolation Library
- Reusable Data Model/Framework

FlexDIT

Flexible Data Ingestion Tool

- Designed to facilitate ingestion of disparate time series data from a variety of sources into CCMC's existing infrastructure
- Describe input data via XML for efficient dataset imports
- Generalized parser works with a variety of formats



Integrated Space Weather Analysis System

- Web-Based Space Weather Dissemination System
- User Configurable, Interactive Products
- Web Services
- Real-Time & Historical Model + Observational Data



StereoCAT CME Analysis Tool

- Determine CME speed and direction
- Create CME height-time measurements
- Create an ensemble of CME measurements
- Save and share measurement sessions



Data Of Notifications, Knowledge, Information

- Catalog of space weather phenomena
- Knowledgebase of interpretations, simulation results, and forecasting analysis
- Online tool for dissemination of forecasts, notifications, & archiving event-focused information

EEGL Eruption Event Generator (Gibson & Low)



- Determine CME speed and direction
- Create CME height-time measurements
- Create an ensemble of CME measurements
- Save and share measurement sessions



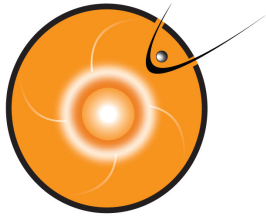
Space Weather Scoreboard

- Research-based forecasting methods validation
- Scientific community submits forecasts in real-time
- View and Compare all forecasting methods

Space Environment Automated Alerts, Anomaly Analysis Assistant (SEA⁵)



- Mission/Location Specific Space Environment Tool
- Automated/Custom Alerts & Notifications
- Assimilate & Display Anomaly Information



Demonstrating Operational Potential (iSWA) SWMF v. 2014 (U. Mich)



Help Save Layout Global Date/Time Clear Layout

Available Cygnets

Solar

Heliosphere

Magnetosphere

Ionosphere

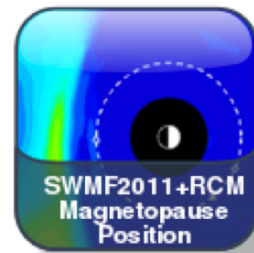
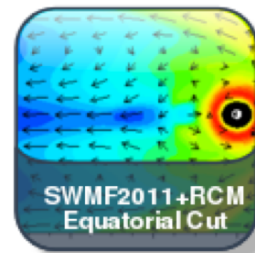
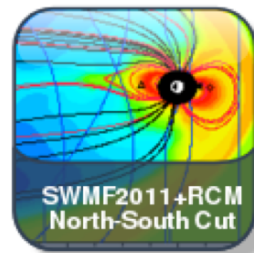
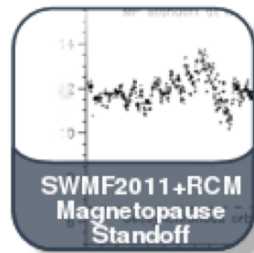
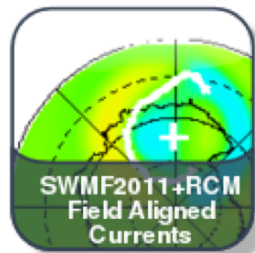
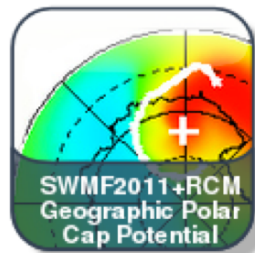
Planetary/Spacecraft

All Cygnets

New Cygnets

Events

bETA



1

2

3

4

5

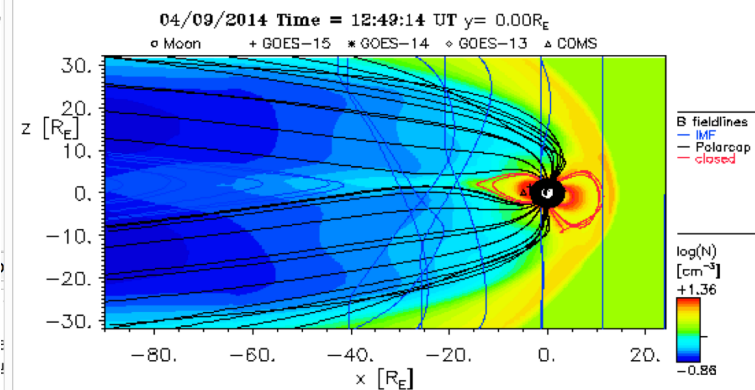
6

7

8

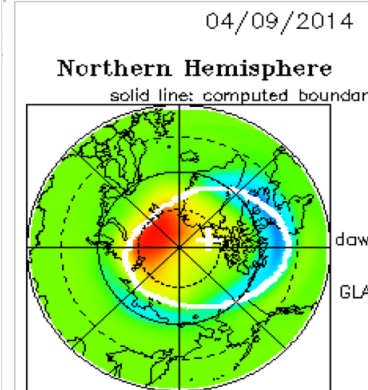
9

SWMF 2011+RCM Magnetosphere - BATSRUS - Y Cut - Magnetic Field Lines



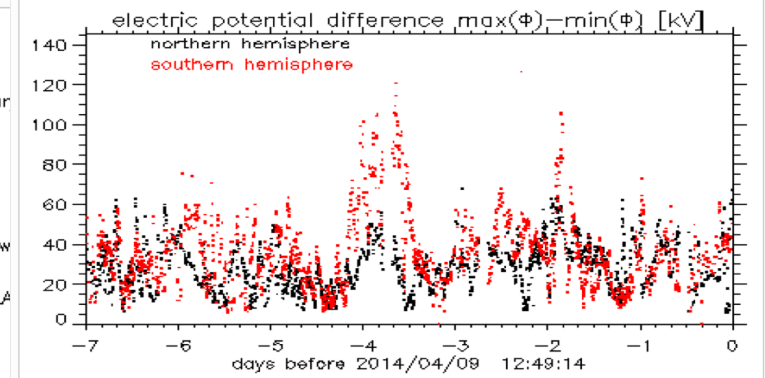
Model at CCMC: BATSRUS

SWMF2011+RCM Ionospheric Field-A



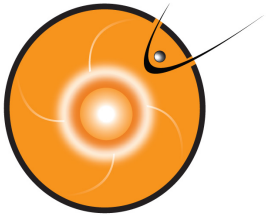
midnight
Model at CCMC: BATSRUS

SWMF2011+RCM 7-day Cross-Polarcap Potential Difference



2014-04-09 12:49:14.0

DST, Ground perturbations (ΔB , dB/dt) timelines



Assessment, Metrics and Validation



Forecasting Methods ScoreBoards



Testing predictive capability before the event onset.

Examples:

CME Arrival Prediction
Storm onsets
Flare Forecasts
SEP Forecasts

Event-Based M&V to Trace Model Improvement

[2003] 10/27 - 10/30
[2006] 12/13 - 12/16
[2010] 04/04 - 04/07
[2011] 08/05 - 08/07

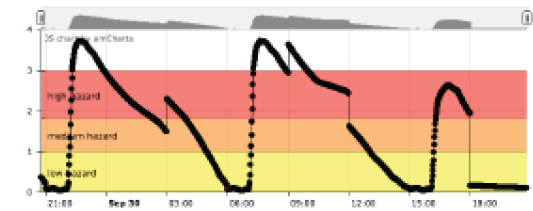
A list of events.
High quality data.
A library of metrics.
Simulate the same set of events over and over...

Examples:

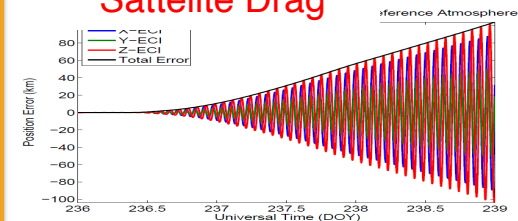
TEC, Neutral density,
Auroral boundaries,
Ground magnetic perturbations dB/dt

Linking Impacts with Space Environment Events

Surface Charging



Satellite Drag



Components:

- database of space environment impacts
- database of events & forecasts



CME Arrival Prediction ScoreBoard



<http://kauai.ccmc.gsfc.nasa.gov/SWScoreBoard/>

The ScoreBoard is a research-based forecasting methods validation activity for CME arrival time predictions which provides a central location for the community to:

- submit their forecast in real-time,
- quickly view all forecasts at once in real-time,
- generate experimental **community-wide ensemble forecasts**,
- compare forecasting methods when the event has arrived

All types of prediction models and methods are welcome from the world-wide community.

There are currently 17 registered CME arrival time prediction methods, including entries from the CCMC/SWRC, SWPC, UK MetOffice, KSFC, COMESEP

CME: 2014-01-07T18:24:00-CME-001							
Actual Shock Arrival Time: 2014-01-09T19:32Z							
Observed Geomagnetic Storm Parameters:							
Max Kp: 3.0							
Columns are sortable!(click column headings)							
Average of all predictions is calculated for the user							
Predicted Shock Arrival Time	Difference (hrs)	Submitted On	Lead Time (hrs)	Predicted Geomagnetic Storm Parameter(s)	Method	Submitted By	
2014-01-10T04:04Z (-16.0h, +36.0h)	8.53	2014-01-08T14:56Z	28.60	Max Kp Range: 8.0 - 8.0 Dst min. in nT: -300	COMESEP	Andy Devos (SIDC)	Detail
2014-01-09T19:26Z (-10.0h, +10.0h)	-0.10	2014-01-07T21:00Z	46.53	----	STOA	Leila Mays (GSFC)	Detail
2014-01-09T13:00Z (-7.0h, +7.0h)	-6.53	2014-01-08T23:17Z	20.25	Max Kp Range: 6.0 - 8.0	WSA-ENLIL + Cone	Duty Forecaster (ASFC)	Detail
2014-01-09T12:00Z (-7.0h, +7.0h)	-7.53	2014-01-08T06:32Z	37.00	----	WSA-ENLIL + Cone	RWC Jeju (KSWC)	Detail
2014-01-09T11:22Z (-11.7h, +9.1h)	-8.17	2014-01-09T18:57Z	0.58	Max Kp Range: 3.0 - 5.0	Ensemble WSA-ENLIL + Cone (GSFC SWRC)	Leila Mays (GSFC)	Detail
2014-01-09T08:02Z	-11.50	2014-01-08T16:37Z	26.92	----	Expansion Speed Prediction Model	Alisson Dallago (INPE)	Detail
2014-01-09T08:00Z	-11.53	2014-01-08T01:31Z	42.02	Max Kp Range: 6.0 - 7.0	WSA-ENLIL + Cone (NOAA/SWPC)	Leila Mays (GSFC)	Detail
2014-01-09T06:35Z	-12.95	---	---	Max Kp Range: 6.0 - 7.625	Average of all Methods	Auto Generated (CCMC)	Detail
2014-01-09T04:30Z (-2.5h, +2.5h)	-15.03	2014-01-08T05:02Z	38.50	Max Kp Range: 5.0 - 8.0	Other (SIDC)	Leila Mays (GSFC)	Detail
2014-01-09T04:00Z (-6.0h, +6.0h)	-15.53	2014-01-08T09:42Z	33.83	----	DBM	Manuela Temmer (UNIGRAZ)	Detail
2014-01-09T02:00Z	-17.53	2014-01-08T17:53Z	25.65	Max Kp Range: 8.0 - 9.0	BHV	Volker Bothmer (UGOE)	Detail
2014-01-09T01:00Z	-18.53	2014-01-08T23:00Z	20.53	Dst min. in nT: -142 Dst min. time: 2014-01-09T12:00Z	Anemomilos	WKent Tobiska (SET SWD)	Detail
2014-01-09T00:38Z (-7.0h, +7.0h)	-18.90	2014-01-08T00:41Z	42.85	Max Kp Range: 6.0 - 8.0	WSA-ENLIL + Cone (GSFC SWRC)	Leila Mays (GSFC)	Detail
2014-01-09T00:17Z (-6.9h, +9.2h)	-19.25	2014-01-08T04:11Z	39.35	Max Kp Range: 6.0 - 8.0	Ensemble WSA-ENLIL + Cone (GSFC SWRC)	Leila Mays (GSFC)	Detail
2014-01-08T22:00Z	-21.53	2014-01-08T03:17Z	40.25	Dst min. in nT: -146 Dst min. time: 2014-01-09T11:00Z	Anemomilos	WKent Tobiska (SET SWD)	Detail
2014-01-08T12:30Z	-31.03	2014-01-08T05:58Z	37.57	----	ESA	Leila Mays (GSFC)	Detail



Flare Forecasts ScoreBoard Planning



Contacts: CCMC (Masha Kuznetsova, Leila Mays), MetOffice (Sophie Murray)
+ ...

Web site: <http://ccmc.gsfc.nasa.gov/challenges/flare.php>

First steps:

- define file format for predictions,
- automate file generation, uploading and archiving procedures,
- move towards calibration of probability forecasts.

Sample file for full disk forecast:

#File name format: Flare_Forecast_modelname_yyyymmdd_hhmm.txt

Forecasting method: MAG4

Time: 2013-10-23T12:00Z

Input data: SDO/HMI LOS_Magnetogram

Prediction window (hours): 24

#Full Disk Forecast

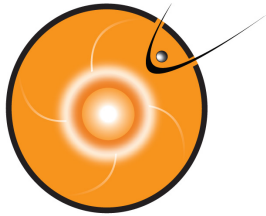
#X_prob	X_uncert	X_Level	M_prob	M_uncert	M_Level	C_prob	C_uncert	C_Level
0.4000	0.0800	3	0.6800	0.0500	3	0.7500	0.0500	3

#X-prob, M-prob, C-prob: Probability of X, M or C class flare in decimal format (4 places)

#X_uncert, M_uncert, C_uncert: Uncertainty in X, M or C class flare probability in decimal format (4 places) (optional)

#X_Level, M_Level, C_Level: Calibration of probability for the model for X, M or C class flares (1=low, 2=medium, 3=high)

#Use ---- when leaving optional fields empty



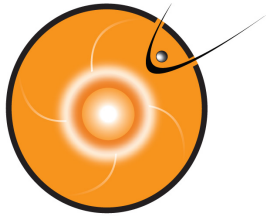
Validation System for 6 Events



Groundbased magnetic perturbations dB/dt and Regional-K study results

Event	Magnetic perturbations on the ground dB/dt	Magnetic perturbations on the ground Delta B	Regional-K
2006/12/14 (doy 348) 12:00 UT - 12/16 00:00 UT	ABK FRD FRN FUR HRN IQA MEA NEW OTT PBQ WNG YKC	ABK FRD FRN FUR HRN IQA MEA NEW OTT PBQ WNG YKC	ABK NEW OTT PBQ WNG YKC
2001/08/31 (doy 243) 00:00 UT - 09/01 00:00 UT	ABK FRD FRN FUR IQA MEA NEW OTT PBQ WNG YKC	ABK FRD FRN FUR IQA MEA NEW OTT PBQ WNG YKC	ABK NEW OTT PBQ WNG YKC
2005/08/31 (doy 243) 10:00 UT - 09/01 12:00 UT	ABK FRD FRN FUR HRN MEA NEW OTT PBQ WNG YKC	ABK FRD FRN FUR HRN MEA NEW OTT PBQ WNG YKC	ABK NEW OTT PBQ WNG YKC
2003/10/29 (doy 302) 06:00 UT - 10/30 06:00 UT	ABK FRD FRN FUR HRN IQA MEA NEW OTT PBQ WNG YKC	ABK FRD FRN FUR HRN IQA MEA NEW OTT PBQ WNG YKC	ABK NEW OTT PBQ WNG YKC
2010/04/05 (doy 095) 00:00 UT - 2010/04/06 00:00	ABK FRD FRN FUR HRN IQA NEW OTT SNK WNG YKC	ABK FRD FRN FUR HRN IQA NEW OTT SNK WNG YKC	ABK NEW OTT SNK WNG YKC
2011/08/05 (doy 217) 09:00 UT - 2011/08/05 09:00	ABK FRD FRN FUR HRN IQA NEW OTT SNK WNG YKC	ABK FRD FRN FUR HRN IQA NEW OTT SNK WNG YKC	ABK NEW OTT SNK WNG YKC

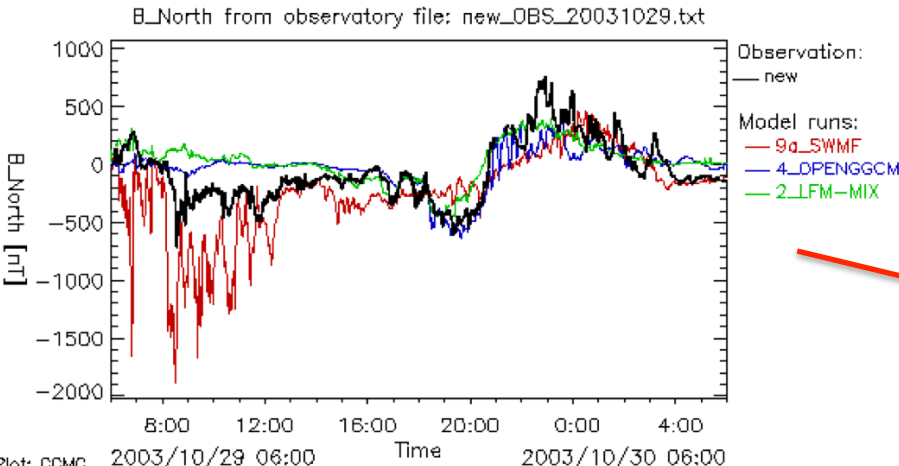
You can also [download Delta B, dB/dt and K-index timeseries files](#).



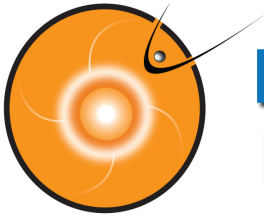
Validation System for 6 Events



Groundbased magnetic perturbations dB/dt and Regional-K study results

Event	Magnetic perturbations on the ground dB/dt	Magnetic perturbations on the ground Delta B	Regional-K
2006/12/14 (doy 348) 12:00 UT - 12/16 00:00 UT	ABK FRD FRN FUR HRN IQA MEA NEW OTT PBO WNG YKC	ABK FRD FRN FUR HRN IQA MEA NEW OTT PBQ WNG YKC	ABK NEW OTT PBQ WNG YKC
 <p>B_North from observatory file: new_OBS_20031029.txt</p> <p>Observation: — new</p> <p>Model runs: — 9a_SWMF — 4_DPENGGCM — 2_LFM-MIX</p> <p>Plot: CCMC 2003/10/29 06:00 2003/10/30 06:00</p>	ABK FRD FRN FUR IQA MEA NEW OTT PBQ WNG YKC	ABK FRD FRN FUR IQA MEA NEW OTT PBQ WNG YKC	ABK NEW OTT PBQ WNG YKC
	ABK FRD FRN FUR HRN MEA NEW OTT PBQ WNG YKC	ABK FRD FRN FUR HRN MEA NEW OTT PBQ WNG YKC	ABK NEW OTT PBQ WNG YKC
	ABK FRD FRN FUR HRN IQA MEA NEW OTT PBQ WNG YKC	ABK FRD FRN FUR HRN IQA MEA NEW OTT PBQ WNG YKC	ABK NEW OTT PBQ WNG YKC
	ABK FRD FRN FUR HRN IQA NEW OTT SNK WNG YKC	ABK FRD FRN FUR HRN IQA NEW OTT SNK WNG YKC	ABK NEW OTT SNK WNG YKC
2010/04/06 00:00 - 2010/04/06 00:00	HRN IQA NEW OTT SNK WNG YKC	HRN IQA NEW OTT SNK WNG YKC	ABK NEW OTT SNK WNG YKC
2011/08/05 (doy 217) 09:00 UT - 2011/08/05 09:00	ABK FRD FRN FUR HRN IQA NEW OTT SNK WNG YKC	ABK FRD FRN FUR HRN IQA NEW OTT SNK WNG YKC	ABK NEW OTT SNK WNG YKC

You can also [download Delta B, dB/dt and K-index timeseries files](#).



Linking Space Environment Models with Engineering Models Calculating Impacts



Space radiation analysis, D. Fry et al., NASA JSC/SRAG

Surface charging modeling, H. Garret et al., NASA JPL

Internal charging, J. Minow et al. , NASA MSFC

SEU modeling, K. Label et al., NASA GSFC

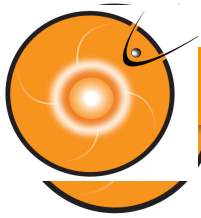
Satellite drag & conjunction assessment, L. Newman, GSFC

.....

Solar Shield, A. Pulkkinen, NASA GSFC

.....

LWS Institutes on linking to space weather applications.



Space Environment Effects (SEE) Database

Database Of Notifications Knowledge Information (DONKI)



Space Environment Effect Report Form

Allow mission specialists to submit SEE reports

Project/Spacecraft Name:

--- Select ---

System:

--- Select ---

Orbit Type:

Chandra X-ray Observatory
International Space Station
Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations

Enter SE Effect Time in UT (yyyy-MM-dd'T'HH:mm:ss'Z' i.e.

2012-02-02T05:30:00Z

--- Select ---

atomic oxygen
drag
radiation event
spacecraft charging
undefined

Search Space Environment Effect and Anomaly Archive

Report Type:

Allow users to search SEE archive

(Optional) Search start date from (e.g. 2013-01-31) : 2012-03-07

(Optional) Search end date to (e.g. 2013-06-30) : 2014-03-07

search

<u>Activity ID</u>	<u>Project Name</u>	<u>System</u>	<u>Effect Time in UT</u>	<u>Orbit Type</u>	<u>Effect Type</u>
2012-03-07T05:30:00-CHANDRA-RAD-001	CHANDRA	instrument	2012-03-07T05:30:00Z	Elliptical	radiation event
2012-03-09T12:00:00-ISS-CHRG-001	ISS	vehicle	2012-03-09T12:00:00Z	Inclined	spacecraft charging

Space Environment Effect Report

Activity ID: 2012-03-07T05:30:00-CHANDRA-RAD-001

Project/Spacecraft Name: Chandra X-ray Observatory

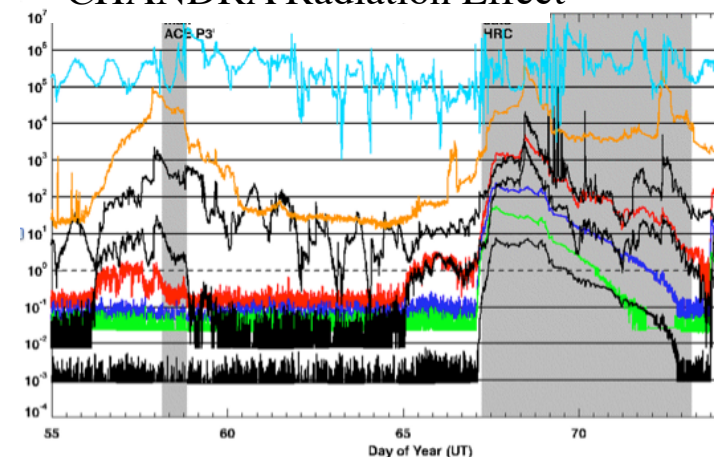
System: instrument

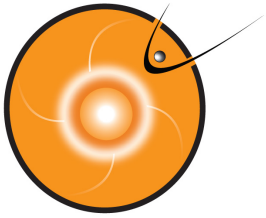
Orbit Type: Elliptical

Effect Time (UTC): 2012-03-07T05:30:00Z

Link SEE reports to space weather activities in DONKI database (Flare, CME, HSS, Geomagnetic Storms, etc)

CHANDRA Radiation Effect





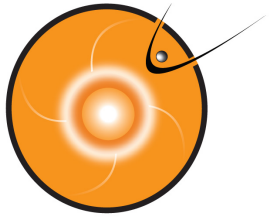
Outlook

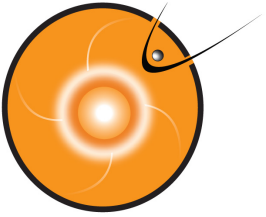


- CCMC is:
 - Asset of NASA & International Space Weather Community.
 - Playground for scientists (facilitate understanding).
 - Hub/desktop for collaborative research & development.
 - Test bed/Showroom/Superstore for end users and operational agencies.

CCMC continues pushing frontiers of space science and space weather research, development and experimental research-based space weather forecasting.

CCMC and SWPC are working together to accelerate implementation of advanced modeling capabilities in SWPC operations.

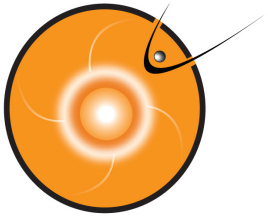




Outline



- R2O V. 2015
- Ongoing activities & initiatives toward accelerating R2O transition.
- Partnership with NOAA/SWPC.
- Summary & outlook



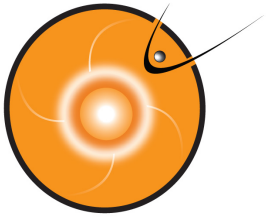
The SEA⁵ System



A system to provide past, present, and predicted space environment information for **specific missions, orbits, and user-specified locations** throughout the heliosphere, geospace, and on the ground.



Search for satellites...



-
- Future joint activities will build upon long-standing and successful CCMC-SWPC collaboration including:
 - research addressing national space weather needs,
 - identification of new promising models for SW purposes,
 - assessment of model predictive capabilities,
 - developing SW displays & tools for SWPC customers,
 - space weather education and forecasters training.
 - CCMC and SWPC will work together to accelerate implementation of advanced modeling capabilities in SWPC operations.